ELECTROMAGENTIC-WAVE GENERATION DEVICE

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to an electromagnetic-wave generation device configured to generate an electromagnetic wave by performing excitation-light irradiation.

[0003] 2. Description of the Related Art

[0004] An electromagnetic wave including a component obtained in a frequency range from the millimeter-wave band to the terahertz-wave band (from 30 GHz to 30 THz inclusive), which is simply referred to as a terahertz wave in this specification, has the following characteristics. First, the electromagnetic wave passes through a nonmetal material as an X-ray does. Secondly, the frequency range includes many absorption spectrums indigenous to biomolecules, pharmaceuticals, etc. Thirdly, the electromagnetic wave has a spatial resolution appropriate in many imaging uses.

[0005] Due to the above-described characteristics of the terahertz wave, the technology of performing the spectral analysis inside a material, a safe transillumination-imaging apparatus replacing an X-ray, the technology of analyzing biomolecules, pharmaceuticals, etc. have been developed as the application fields of the terahertz wave. A terahertz-wave generation method performed by using a photoconductive element is widely used as the method of generating the terahertz wave. The photoconductive element includes a special semiconductor having relatively large mobility and the carrier life not more than a picosecond long, and two electrodes provided on the semiconductor. When light is applied to the gap between the electrodes in the state where a voltage is applied between the electrodes, a picosecond-order current flows between the electrodes and the terahertz wave is emitted.

[0006] The intensity of an electric field provided between the electrodes should be increased to increase an output of the terahertz wave. A generation apparatus provided to increase the electric field intensity has been disclosed in Japanese Patent Laid-Open No. 2006-074021. The generation apparatus does not include the above-described photoconductive element. The generation apparatus illustrated in FIG. **10** includes a substrate **11**, a vacuum part **15**, a positive electrode **12**, and a negative electrode **13**. The surface part of the negative electrode **13** includes a photoelectric plane **14** provided to emit an electron **16** to the vacuum part **15** by being irradiated with light. The material of the photoelectric plane **14** includes Sb, K, Na, Cs, etc. A power source **20** applies a relatively high voltage to the gap between the positive electrode **12** and the negative electrode **13**, where the vacuum part **15** lies therebetween.

[0007] Unlike the photoconductive element, a time period τ during which a current emitted from the photoelectric plane **14** flows is determined based on a distance d of the gap between the positive electrode **12** and the negative electrode **13**, and the voltage V. For example, when the voltage V applied to the gap between the electrodes **12** and **13** is 100V, and the gap distance d is 2 μm, the time period τ is estimated to be 0.67 psec. Accordingly, when the photoelectric plane **14** is irradiated with pulse light **131** having a short width measured in femtoseconds (with a wavelength of about 780 nm), the pulse light **131** being emitted from a laser device **30**, an induced current flows into an antenna (between the electrodes **12** and **13**) only during the time period τ, and a terahertz wave is emitted from the antenna. Thus, the technology disclosed in Japanese Patent Laid-Open No. 2006-074021 achieves a larger electric-field intensity and a larger output of the terahertz wave than the method performed by using the photoconductive element.

[0008] The emission current properties of the above-described electromagnetic-wave generation apparatus will be described below. Firstly, since the emission current properties of a vacuum-tube element correspond to the function of an electric field provided between the negative and positive electrodes, the distance between the negative and positive electrodes should be highly consistent throughout the width of each of the electrodes, which is difficult due to processing accuracy. Secondly, since the emission current properties of the vacuum-tube element depend on the work function of the material of the negative electrode, a change in the work function, which is caused by, for example, the adhesion of an adsorption material to the surface of the vacuum-tube element, may cause an emission current to change. Thus, the emission current properties of the electromagnetic-wave generation apparatus, which has the original characteristics of the above-described vacuum-tube element, should be more stable.

SUMMARY OF THE INVENTION

[0009] The present invention provides an electromagnetic-wave generation device including an emitter section including a first electrode, a collector section including a second electrode, a carrier-travel section placed between the emitter section and the collector section, a voltage-application unit configured to apply a voltage so that a potential of the second electrode becomes higher than a potential of the first electrode, and a light-irradiation unit configured to radiate light, wherein the carrier-travel section includes a first semiconductor extending along a direction in which an electron carrier travels, and wherein the emitter section includes a second semiconductor that is formed in contact with the first semiconductor, and that achieves a potential barrier, and is configured so that the carrier goes beyond the potential barrier and is emitted to the carrier-travel section only when being irradiated with the light.

[0010] According to an embodiment of the present invention, the vacuum provided in the related art is replaced by a solid semiconductor (usually, a substantially intrinsic semiconductor thinner than the mean free path), which allows for the ballistic flight of an electron (or a hole), the ballistic flight being substantially the same as that achieved in a vacuum. The use of the solid semiconductor allows for selecting the method of manufacturing a solid element that can control the distance between an emitter and a collector with high precision, where the semiconductor is placed between the emitter and the collector. Consequently, an electromagnetic-wave generation device with stable emission current properties can be achieved.

[0011] Further features of the present invention will become apparent from the following description of exemplary embodiments with reference to the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] FIG. **1**A is a sectional view illustrating an exemplary configuration of an electromagnetic-wave generation device according to a first embodiment of the present invention.